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An Analysis of the Production Output Difference Between an 11-pica and a 15-pica Line Width

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AN ANALYSIS OF THE PRODUCTION OUTPUT DIFFERENCE BETWEEN AN 11-PICA AND A 15-PICA LINE WIDTH

BY

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This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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CHAPTER I

OBJECT OF THE STUDY

Considerable research has been done on newspapers in the areas of type sizes, type faces, leading between lines, readability, legibility, and column widths (5,7,14). Miles A. Tinker and Donald R. Paterson, University of Minnesota psychologists, found that 19-pica lines were the optimum width for 10-point type. They found that when column widths were reduced to 14 picas, reading speed was reduced by 4.2 per cent, and when column widths were reduced to 9 picas, reading speed was reduced by 6.7 per cent (12).

Tinker and Paterson conducted another study to determine the influence of line width and leading on the speed of reading 9-point type. The results indicate that an optimal rate of reading occurs with line widths of 14 to 30 picas and with 1 to 4-points leading. A conservative range would be a 16 to 24-pica line width with 1 to 4 points leading (13). The modern 11-pica newspaper column appears, therefore, to be considerably more difficult to read than an optimum-width column ranging from 16 to 24 picas in width.

Donald R. Murphy, for many years research director for Wallace's Farmer and the Wisconsin Agriculturist, found that actual readership by male readers would increase if the column width and the type size were increased. In a split run of two different forms of a story in Wallace's Farmer he found that 41 per cent of the men readers read a story set in 9-point type in 12½-pica width, but that

50 per cent read the same article set in 10-point type in 16½-pica width (7).

The results of a study conducted by J. K. Hvistendahl on Reader Estimates of Reading Time and Attractiveness of Type in Six Different Forms at South Dakota State University seem to support Tinker and Paterson's conclusions that the wider column widths are more efficient. Hvistendahl found that in general, subjects estimated that they could read the wider 16-pica measure more rapidly than the narrower 11-pica measure. As to attractiveness and reading speed, the subjects again ranked the 2-column 16-pica form first (8).

The Tinker and Paterson studies dealt with reading speed; the Murphy study concerned the proportion of readers who actually read the stories in the alternate forms, and the Hvistendahl study concerned reader estimates of attractiveness and reading speed of type set in two widths. This study deals with the typesetting speed, or the actual amount of written material that can be composed by a line-casting machine operator in two different column widths in a given period of time.

The costs involved and the time consumed in the typesetting operation of today's newspaper are extremely high. Although not much can be done to reduce these costs because of the high cost of machinery and amount of skilled labor required, a significant time savings might be realized if it could be demonstrated that type set in one width could be set significantly faster than type set in some

other width. Therefore, the objective of this research is to determine the production output difference, if such a difference exists, between the amount of type set on the standard 11-pica newspaper column as compared to a 15-pica column.

It is also the objective of this study to determine the difference in hyphenation between the two measures, and the difference in words set per 100 ems between the two measures, if such differences exist.

Today many newspapers try to reduce typesetting costs by using Linotypes operated automatically by perforated tapes. This operation, however, involves an extra step because someone must first punch the tape on another machine, the Teletypesetter Perforator.

Computers are also used today to speed up the typesetting operation. But of the 8,250 newspaper publishing establishments querried by the American Newspaper Publishers Association, only 23, or fewer than one per cent, now employ Computers (10). The reason for this small number is undoubedly due to the high cost involved in the installation and upkeep of complicated and highly technical computer typesetting systems. Therefore, the majority of newspapers are still faced with the task of setting type manually on line casting machines. Only the largest newspapers, such as the Los Angeles Times, can afford the multi-million dollar computer installations that are necessary to compute word hyphenation for continuously set copy for tape operated machines.

At the present time there are only four general circulation newspapers that have broken from tradition and changed to a wider column measure. The first paper to change was The Wall Street Journal followed by The National Observer. The most recent newspaper to change was The Christian Science Monitor. The Monitor took on its new look on March 1, 1965. An article from that edition reads in part:

> The Christian Science Monitor today introduces major typographical changes designed to make the Monitor easier to read:
>
> 1) The traditional eight-column newspaper layout is replaced with a five-column width for news and feature matter, a very desirable length of line for readability.
>
> 2) The size of the body type has been enlarged from 7½ point to 9 point, a twenty per cent increase, to improve legibility.
>
> 3) Headline style has been streamlined. Capital letters have been eliminated except on the initial word and on proper names.
>
> 4) Column rules have been removed. White space is used more generously. (6-1)

In this same issue of The Christian Science Monitor, Edmund C. Arnold, chairman of the graphic arts department of the Syracuse University School of Journalism, made the following comment about the Monitor's new look:

> The Christian Science Monitor that you are reading may well be a preview of the American newspaper of 1985. At least that is the belief of many observers of the journalistic world.
>
> The Monitor's new typography has been adopted to make it easier, more convenient, more pleasant for the reader to obtain maximum information. (6-2)

The type now being used on the Monitor is 9-point Excelsior set on a column width of 16 3/4 picas.

Another newspaper that recently made the change to the wider column was The Courier-Journal of Louisville, Kentucky (4). This was the first time in the Journal's 138-year history that such an experiment had ever been tried. The purpose of the experiment was to see what a six-column newspaper would look like and to obtain reader reaction to the wider columns.

The Courier-Journal management listed these reasons for the change:

> 1) The 11-pica line width is too short for easy readability. Typographical experts are convinced that 8 and 8½-point type on a 15-pica width is nearly the ideal size. We are close to that in this edition.
>
> 2) The 11-pica width imposes great limitations on the headline writing. No one knows the man-hours spent on copy desks struggling to write good headlines in 11-pica restrictions.
>
> 3) Mechanically, the speed of typesetting, whether manual or TTS, is increased in terms of characters per hour by longer line lengths. Further, the frequency of hyphenation is reduced by longer line lengths. Normally, we hyphenate one line in five. We believe this edition will show a significant reduction in hyphenation.
>
> 4) Checks show that all national magazines presently have column widths of approximately 13.6 picas. This raises the speculative point as to whether our narrow column widths foreclose opportunities for advertising which one might otherwise obtain. Obviously, it is easy for any newspaper to alter requirements for local advertising, but it would require widespread industry action to sharply change requirements for national advertising. (4-12)

The Courier-Journals normal column width is 11 picas, and in this single experimental issue the column width was widened to 14.9 picas.

The third reason listed by The Courier-Journal, the possible increase in typesetting speed and the decrease in hyphenation, is the basis of this research. If it can be found that a significant production output difference exists, in terms of the amount of type set in the two widths, this study will have accomplished its objective.

The reason for choosing 15 picas as an ideal column width to compare against the 11-pica column is that The Wall Street Journal and The National Observer are both set on the wider measure. Also, most printers use the formula of $1\frac{1}{2}$ times the lower case alphabet length of the type used to determine the ideal line length (9). When this formula is applied to the type used in this experiment, the line length derived is approximately 15 picas.

CHAPTER II

METHODOLOGY

Controlled Variables

The line casting machine is an integral part of the modern newspaper's typesetting department. The maximum speed of these machines can be ascertained by checking with the manufacturer of the machine. However, there are many other variables beside maximum speed which affect the actual production of line casting machines.

During the testing period of this study, the following variables were controlled: Operator's setting time, alphabet length of type used, spaceband thickness, elapsed time of the test, and machine and distributor stops.

The operator's setting time was controlled by having him set both the 11-pica and 15-pica measure for the same time period, using equivalent forms. In this respect, as long as the operator was consistent, the test would be valid.

A second variable controlled was the size and alphabet length of the type used. The alphabet length refers to the length, in points, of the 26 characters that make-up the lower case alphabet. Since most modern newspapers use type faces with alphabet lengths of approximately 129 points, an attempt was made to use type faces with equivalent alphabet lengths.

A third variable controlled was the thickness of the spacebands used. Most modern newspapers use the jumbo-size spacebands. These

bands are capable of taking up more space in the line which reduces slightly the necessity for hand spacing.

A fourth variable controlled was the elapsed time of the test, which was five minutes for both the 11-pica and 15-pica measure. A stop watch was used to determine the duration of the typesetting time.

Final variables controlled were machine and distributor stops. Since these occurred unexpectedly, the watch was stopped for the time needed to clear the stop. The reason for stopping the clock was that the operator was technically not operating during this period. Distributor stops are a function of the mechanical condition of the line casting machine or the condition of the brass matrices from which the letters are cast. These stops are largely independent of the copy being set.

The experimenter manipulated two variables in this study length of line and copy. Operators set equivalent reading forms at an 11-pica measure and at a 15-pica measure. To eliminate any order bias, the equivalent forms were alternated between the two measures for each subject, the 11-pica measure being given first to one subject and the 15-pica measure given first to the next subject.

The above variables are considered to be the most important variables affecting the outcome of this study, but the author realizes that there is the possibility that other variables could have had an effect.

Machines Used

In the composing room of modern newspapers, several different models of line casting machines are used. Although each model has its own individual characteristics, its purpose is to produce type as efficiently and as rapidly as possible.

The determining factor for the machines used in this experiment was availability. Although it would be theoretically desirable to use only one model of one machine, three different Linotype models were used: Model 8, Model 14, and Model 32.

The Model 8 Linotype and the Model 14 Linotype are essentially the same machines. They differ only in that the Model 14 has an auxiliary magazine of 28 channels located on the right of the main magazine. This auxiliary magazine may be operated by a special keyboard located to the right of the main magazine, or if it is a single keyboard model, the auxiliary magazine is operated from the main keyboard (1, 11).

The Model 32 is a later Linotype model and differs from the above two models because it operates from a main magazine and from four 34-channel-wide auxiliary magazines. The matrices from any one of the auxiliary magazines may be mixed with matrices from any main magazine and then properly distributed without any extra effort on the part of the operator (1, 11).

The different line casting machines used in this experiment were capable of producing type at different speeds. However, all the line casting machines had sufficient speed to permit the operator

to set at his own speed without impediment. Therefore, the maximum or potential speed of the various machines was not a factor in the experiment.

Type Used

Most newspapers today use a typeface that is classified as modern in design. An example of such a face would be Corona, usually 9 points in size. It is commonly used for the newspaper's straight matter. In this study, however, the actual printed appearance of the type face made no difference because the operators were being compared as to the amount of type they could set on the two measures in the given time period. The limiting factor in the type face selection was the alphabet length of the type used.

The alphabet lengths of the modern newspaper type faces, which measure 9 points in size, are approximately 129 points. The four type face alphabet lengths used in this experiment ranged from 104 points to 130 points. The majority of the subjects set 10-point Caledonia (10△496), with an alphabet length of 130 points. The other three type faces used were 8-point Corona (8△568), alphabet length 118 points; Granjon (10△376), alphabet length 117 points; and 9-point Spartan (9△98), alphabet length 104 points (2,15).

The experimenter attempted to use type faces with equivalent alphabet lengths in order to keep the experimental conditions as close to actual newspaper typesetting conditions as possible, but the scarcity of Linotypes in the Brookings area with identical type faces made this impossible.

Spacebands Used

Spacebands are an essential and integral part of the line casting machine. They are the slim, steel wedges that are forced upward during the casting cycle. They provide even spacing between words, insure exact justification for each line cast, and guarantee a tight fit between the vice jaws during the casting cycle (1).

Most newspapers today use the largest spacebands available, that is, those bands that are capable of expanding more and thus reducing the necessity of hand spacing. In this experiment five different thicknesses of spacebands were used: teletypesetter, thin, extra thick, extra thin, and jumbo. The majority of the operators used teletypesetter bands which are comparable in size to the extra thick and jumbo bands.

Here again, the size spacebands used by newspapers were used whenever possible to keep the experimental conditions as close as possible to actual newspaper publishing conditions. A look at Table I will show the machines, type and spacebands used in the experiment.

Table 1. Machines and equipment used in actual experiment

Type of Linotype	Point Size of Type	Style of Type	Alphabet Length in Points	Size of Spacebands
Model 8	10	Caledonia	130	Teletype
Model i	8	Corona	118	Thin
Model 14	8	Excelsior	126	Extra Thick
Model 14	10	Granjon	117	Extra Thin
Model 32	9	Spartan	104	Jumbo

Copy Used

The copy set by the operators in this experiment consisted of two diagnostic reading test forms that had been proven equivalent as to reading difficulty. It was assumed that since these two copies were equally difficult to read, they would be equally difficult to set on a line casting machine.

This type of copy was chosen to reduce the possibility of having two different copies, selected at random, being unequal in reading difficulty and therefore, unequal in typesetting difficulty. The copy actually used in the experiment was typed on a pica typewriter and double spaced. Copies were then reproduced by the mimeograph process. The copy appears in the appendix.

Procedure

The operators used in this experiment consisted of printing students, printing department faculty members, and printing production employees of South Dakota State University. Local printers from Brookings and Volga also participated in the experiment.

To begin the test, each operator first set-up the machine for the line width desired. He was then given some copy to warm-up on and get used to the machine. The warm-up copy appears in the appendix.

After the warm-up period, which usually lasted from five to ten minutes, the operator was given, for example, Copy A to set on the 11-pica measure. He was then told to indent paragraphs one em quad, to be as accurate as possible. It was made clear to him that should he have a machine or distributor stop while operating that he should clear it and resume operating as soon as possible. The operator was then told to begin operating whenever he was ready.

The idea that this experiment was not a race was impressed on the operators. They were told to operate at their normal or regular speed and to be as consistent as possible on each measure.

After the five minute setting time had elapsed, the operator was told to stop, to finish the word he was on, and to quad out the rest of the line.

The second phase of the test started by having the operator change the machine over to a 15-pica line width. A pi-line was then sent through to make sure that the machine adjustments had been made properly. The operator was then given Copy B and told again to indent paragraphs one em quad, to be as accurate as possible and should he

have a machine or distributor stop while operating to clear it and resume setting as quickly as possible. He was then told to start setting whenever he was ready. At the end of the five minute period, the operator was told to stop, to finish the word he was on, and to quad out the rest of the line. This completed the test. A proof was then pulled of the type set and filed away for later tabulation.

Every operator was given fresh copy to arrange in the copy holder in any manner he desired. Copy A and Copy B both consisted of two pages, typed in pica type and double spaced. This was done to insure that the fastest operators would not run out of copy before the five minute testing period elapsed.

When an operator had a machine or distributor stop, the stop watch was stopped while the operator cleared the machine. The thinking behind this procedure was that the operator was not actually setting type during this brief period, and the stop was caused by mechanical, rather than operator-caused reasons.

The next operator was given the same instructions and followed the same procedure as did the first operator. The only change made in his procedure, however, was to start setting the 15-pica measure first. In other words, the first operator started setting Copy A on 11 picas, followed by Copy B on 15 picas. The second operator began by setting Copy A on 15 picas, followed by Copy B on 11 picas. This procedure was followed throughout to reduce a possible order bias.

Before statistical analysis, the experimenter checked the proofs for errors, the ems set on each measure, the number of hyphenated words in each measure, and the number of words set per 100 ems on each measure. The results of these and other findings will be discussed fully in the next chapter.

CHAPTER III

FINDINGS

Ems Set on the 11-Pica Measure as Compared to Ems Set on the 15-Pica Measure

The main objective for undertaking this study was to determine the production output difference, if such a difference existed, between the amount of type set on an 11-pica measure as compared to the amount of type set on a 15-pica measure in a given time period.

It has been found in previous research studies that a line width of approximately 15 picas is much more readable than a line width of 11 picas. Therefore, if it is found that more type can be set on a 15-pica measure than on an 11-pica measure in a given time period, further support will be given to the hypothesis that wider measures of type are more efficient for newspaper and magazine use than narrower measures of type.

Another objective of this experiment was to determine the difference in number of errors made on each measure, the difference in amount of hyphenization on each measure, and the number of words set per 100 ems on each measure. Table 2 shows the gross and net ems set on each measure, the errors made on each measure, and the number of hyphenations made on each measure. (The number of words set per 100 ems on each measure will be discussed later in this chapter.)

Table 2. Gross and Net Ems, Errors, and Hyphens for two Measures of Type

	11 Picas (30 Operators)	15 Picas (30 Operators)
Gross Ems	7223.4	9808.5
Net Ems	6017.8	7067
Errors	83	95
Hyphens	67	77

The unit of measurement, used to determine whether such a difference existed, was the em. Hoch describes the em in the following way:

> The measurement factor of the composing room product is the em. This unit of production is obtained by measuring the width and depth of the type matter that has been set. The measurement is made with a pica rule and designates picas. This is transformed to ems of the size of type which has been set. The product of the multiplication of the width and depth of the set type matter gives the number of ems in the job. (3-40)

Gross ems are the total number of ems set by each operator in the five-minute time period. The criterion used to determine net ems, was to deduct one line from each column width for every error made. However, if an operator made more than one error in a single line, only that line was deducted. The reason for this method of determining errors is that the operator would have to reset only one line to make the correction. Furthermore, in the case of a word hyphenated incorrectly, two lines were deducted. The reason for this

is that the operator would have to reset both lines to make the correction.

After tabulating the gross ems set from both Copy A and Copy B for both the 11- and 15-pica measures, Fischer's t-test was applied to ascertain whether the difference in the number of ems set was significant. This difference was found to be significant beyond the .01 level. In other words, there were significantly more ems set on the 15-pica measure than on the 11-pica measure.

If this finding were shown as a per cent, there were 35.8 per cent more gross ems set on the wider 15-pica measure than on the narrower 11-pica measure. Therefore, if gross ems were used alone as a criteria for change, they would seem to indicate that by changing from the standard 11-pica newspaper column to a wider and more readable column width of 15 picas, considerably more type could be set in the same length of time. Table 3 shows the gross ems set by 30 operators from Copy A and Copy B on the 11- and 15-pica measures.

To show the comparison of gross ems set by each operator, Table 3 has been divided into four columns. The first two columns show the gross number of ems set from each copy on each measure by the first 15 operators. The second two columns show the gross amount of ems set from each copy on each measure by the second 15 operators.

Table 3. Gross Ems Set by 30 Operators from Copy A and Copy B on the 11- and 15-Pica Measures

Copy A 11 Picas	Copy B 15 Picas	Copy B 11 Picas	Copy A 15 Picas
(15 Operators)		(15 Operators)	
478.5	517.5	409.2	504.0
346.5	427.5	343.2	504.0
303.6	288.0	237.6	414.0
356.4	468.0	105.6	144.0
158.4	180.0	158.4	198.0
330.6	414.0	92.4	126.0
478.5	427.5	132.0	252.0
270.0	264.0	145.2	198.0
171.6	240.0	79.2	126.0
105.6	180.0	145.2	180.0
171.6	234.0	132.0	162.0
132.0	162.0	337.6	396.0
250.8	288.0	303.6	378.0
356.4	450.0	132.0	144.0
428.3	580.0	132.0	180.0
Means: 289.2	341.3	192.3	260.2

The author was also interested in ascertaining whether the difference in the number of net ems set on each measure would be significant. To review, net ems were calculated by deducting one line from each column width for each error made. Table 2 shows the net ems set on each measure by the 30 operators.

Fisher's t-test was again applied, and the difference was found to be significant beyond the .01 level. If this finding were shown as a per cent, there were 17.4 per cent more ems set on the wider 15-pica measure than on the narrower 11-pica measure. It should be noted, however, that although both the gross and net differences were significant beyond the .01 level, the net em increase was not as far beyond the .01 level as was the gross em increase. Table 4 shows the net ems set by the 30 operators from Copy A and Copy B on the 11- and 15-pica measures.

Table 4. Net Ems Set by 30 Operators from Copy A and Copy B on the 11- and 15-Pica Measures

Copy A 11 Picas (15 Operators)	Copy B 15 Picas (15 Operators)	Copy B 11 Picas (15 Operators)	Copy A 15 Picas (15 Operators)
478.5	495.0	396.0	432.0
330.0	337.5	343.2	432.0
237.6	270.0	184.8	252.0
356.3	450.0	13.2	36.0
79.2	18.0	92.4	162.0
303.6	342.0	66.0	54.0
429.0	360.0	66.0	180.0
181.5	112.5	145.2	162.0
132.0	198.0	26.4	72.0
105.6	108.0	105.6	180.0
171.6	198.0	118.8	72.0
79.2	108.0	198.0	342.0
237.6	270.0	237.6	198.0
240.4	378.0	132.0	144.0
411.6	560.0	118.0	144.0
Means: 251.5	280.3	149.5	190.8

It should also be brought out, that of the 30 operators used in this experiment, three operators set more type on the 11-pica measure in the five minute period than they did on the 15-pica measure in the same time period. The speed with which they set the 11-pica measure, however, was not significantly greater than the speed with which they set the 15-pica measure.

The only reason the author can give for this occurrence is that these particular operators were perhaps more accustomed to setting on the 11-pica measure. Two of these three operators also had some spaceband trouble on the 15-pica measure. The third operator, who had not set type for some time, started with the 15-pica measure. It may be believed that during the first five minute testing period he had more time to warm-up and get accustomed to the machine and therefore, did better on the 11-pica measure during the second five minute testing period. Table 5 shows the scores of these three operators.

Table 5. Gross Ems Set by the Three Operators who Set the 11-Pica Measure more Rapidly

11 Picas (3 Operators)	15 Picas (3 Operators)
478.5	427.5
303.6	288.0
270.0	264.0

Errors Per 100 Ems for the 11-Pica Measure as Compared to Errors Per 100 Ems for the 15-Pica Measure

If it were found that there were significantly more errors made on the 11-pica measure than on the 15-pica measure, the feasibility of changing to the longer line width would be greatly enhanced. If it were shown on the other hand, however, that there were significantly more errors made on the 15-pica measure, it would support the decision to retain the narrower measure. Table 2 shows the total number of errors made on each measure.

The findings of this study neither affirm nor refute either of the above two propositions. It was found that the difference in errors made on each measure was not significant. Although there were more total errors made on the 15-pica measure, it may be assumed normal due to the greater number of ems being set on that measure. Table 6 shows the errors made per 100 ems on the 11-pica measure from both Copy A and Copy B. Table 7 shows the errors made per 100 ems on the 15-pica measure from both Copy A and Copy B.

Table 6. Errors made Per 100 Ems of the 11-Pica Measure from both Copy A and Copy B

Gross Ems Set (30 Operators)	Gross Number of Errors	Errors Per 100 Ems
478.5	0	0
346.5	1	.3
303.6	5	1.6
409.2	1	.2
343.2	0	0
353.4	0	0
237.6	4	1.7
158.4	6	3.8
330.0	2	.6
478.5	3	.6
270.0	5	1.9
105.6	7	6.6
158.4	5	3.2
92.4	2	2.2
132.0	5	3.8
145.0	0	0
79.2	4	5.0
145.2	3	2.1
171.6	3	1.7
132.0	1	.8
105.6	0	0
337.6	3	.9
171.6	0	0
303.6	5	1.6
132.0	4	3.0
132.0	0	0
250.8	1	.4
132.0	1	.8
356.4	5	1.4
428.3	1	.2
Means: 240.8	2.7	.87

Table 7. Errors made Per 100 Ems on the 15-Pica Measure from both Copy A and Copy B

Gross Ems Set (30 Operators)	Gross Number of Errors	Errors Per 100 Ems
517.5	1	.2
427.5	2	.9
504.0	2	.4
504.0	2	.4
288.0	1	.3
468.0	1	.2
414.0	6	1.4
180.0	9	5.0
414.0	3	.7
427.5	3	.7
264.0	7	2.7
144.0	6	4.2
198.0	2	1.0
126.0	3	2.4
252.0	4	1.6
198.0	2	1.0
126.0	3	2.4
198.0	0	0
240.0	4	1.7
162.0	5	3.1
180.0	4	2.2
396.0	3	.8
234.0	2	.9
378.0	10	2.6
162.0	0	0
144.0	1	.3
180.0	2	1.1
450.0	4	.9
580.0	1	.2
Means: 326.9	3.2	1.03

Hyphenated Words Per 100 Ems for the 11-Pica Measure as Compared to Hyphenated Words Per 100 Ems for the 15-Pica Measure

A second subsidiary objective for undertaking this experiment was to determine whether fewer hyphenations would be required on a 15-pica measure than on the 11-pica measure, when the amount of copy is held constant.

When an operator comes to the end of a line which requires a word to be hyphenated, he either knows where to hyphenate the word, or, in some instances, he must stop and look the word up in a dictionary. Although this may seem like a very short pause, over a day's time and multiplied by many more operators, the extra time required for more frequent hyphenizations could amount to a substantial loss in production time. But if a significant decrease in the number of hyphenizations could be found by changing from the traditional 11-pica newspaper column to a wider column of 15-picas, further support will be given to the hypothesis of this study. Table 2 shows the number of word hyphenations for each measure.

To determine whether such a reduction occurred, hyphens per 100 ems were calculated for both the 11- and 15-pica measures. It was found, by using the t-test, that the 15-pica measure had significantly fewer hyphenated words per 100 ems than did the 11-pica measure. This significance was beyond the .01 level.

Since the 15-pica measure had significantly fewer word hyphenations, it may be assumed that the chance for error has also decreased slightly. In addition, since significantly fewer word hyphenations are required, the operator presumably will be called upon to stop less frequently and look words up in a dictionary, thereby increasing his production time. Table 8 shows the hyphenated words per 100 ems on the 11-pica measure. Table 9 shows the hyphenated words per 100 ems on the 15-pica measure.

Table 8. Hyphenated Words Per 100 Ems on the 11-Pica Measure

Gross Ems Set (30 Operators)	Gross Number of Hyphens	Hyphens Per 100 Ems
478.5	1	.2
346.5	2	.6
303.6	5	1.2
409.2	3	.9
343.2	1	.3
353.4	2	.6
237.6	3	1.3
158.4	2	1.3
330.0	1	.3
478.5	4	.8
270.0	1	.4
105.6	0	0
158.4	2	1.3
92.4	3	3.2
132.0	2	1.5
145.2	2	1.4
79.2	0	0
145.2	2	1.1
171.6	2	1.2
132.0	6	4.5
105.6	0	0
337.6	5	1.5
171.6	1	.6
303.6	5	1.6
132.0	2	1.5
132.0	3	2.3
250.0	1	.4
132.0	2	1.5
356.4	2	.6
428.3	2	.5
Means: 240.8	2.2	1.1

Table 9. Hyphenated Words Per 100 Ems on the 15-Pica Measure

	Gross Ems Set (30 Operators)	Gross Number of Hyphens	Hyphens Per 100 Ems
	517.5	0	0
	427.5	6	1.4
	504.0	5	1.0
	504.0	5	1.0
	288.0	1	.3
	468.0	1	.2
	414.0	5	1.5
	180.0	4	2.2
	414.0	8	2.0
	427.5	2	.5
	264.0	2	.8
	144.0	1	.7
	198.0	2	1.0
	126.0	2	1.6
	252.0	3	1.2
	198.0	1	.5
	126.0	0	0
	180.0	2	1.1
	240.0	1	.4
	162.0	2	1.2
	180.0	0	0
	396.0	5	1.3
	234.0	2	.9
	378.0	5	1.3
	162.0	3	1.9
	144.0	0	0
	288.0	2	.7
	180.0	2	1.1
	450.0	1	.2
	580.0	4	.7
Means:	326.9	2.6	.9

Words Per 100 Ems Set on the 11-Pica Measure as Compared to Words Per 100 Ems Set on the 15-Pica Measure

A final subsidiary objective for undertaking this experiment was to ascertain whether a fixed amount of copy set on a 15-pica measure contained significantly more words per 100 ems than the same amount of copy set on an 11-pica measure. Calculated from the total number of gross ems set by the 30 operators, there were more words per 100 ems set from Copy A and Copy B on the 15-pica measure as compared to words per 100 ems set from the same copy on the 11-pica measure.

Due to the impossibility of having all 30 operators use one machine and one type face, only 24 of the 30 operators were used in determining the number of words that could be set in 100 ems of type. The reason for this is that all 24 of these operators used the same machine and the same type face.

As stated above, the 15-pica measure contained more words per 100 ems than did the 11-pica measure. This difference, however, was found to be not significant, but the difference favors the 15-pica measure in both the "A" and "B" comparisons. It was also found that the average word length in Copy A was 4.45 characters per word and the average word length in Copy B was 4.49 characters per word. Therefore, word length was not an important factor in this comparison.

One reason for more words per 100 ems being set on the 15-pica measure may have been the significant reduction in the number of word hyphenizations required on that measure. When a word is hyphenated

it takes up two spaces, one space for the hyphen and a second space for the remainder of the hyphenated word carried over to next line. Table 10 shows the words set per 100 ems by 24 operators from Copy A and Copy B on the 11- and 15-pica measures.

Table 10. Words Set Per 100 Ems by 24 Operators from Copy A and Copy B on the 11- and 15-Pica Measures

Copy A 11 Picas (10 Operators)	Copy B 11 Picas (14 Operators)	Copy A 15 Picas (14 Operators)	Copy B 15 Picas (10 Operators)
39.0	34.7	40.0	33.5
39.5	34.7	41.0	36.0
40.0	34.7	41.0	34.0
39.0	36.0	41.0	33.0
43.0	35.0	41.0	34.3
40.0	31.0	41.0	36.0
39.7	34.0	40.5	34.3
39.7	34.3	41.0	33.5
39.5	35.0	41.0	33.0
39.7	34.0	41.0	35.0
----	33.0	41.0	----
----	33.0	38.0	----
----	34.7	40.5	----
----	33.0	41.0	----
Means: 39.9	31.9	40.6	34.3

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

SUMMARY

Although there has been considerable research done on newspapers in the areas of type sizes, type faces, leading between lines, readability, legibility, and column widths, very few newspapers have taken full advantage of these research findings. Most newspapers today use a type face that has been found, through research, to be more legible, but these newspapers still use the narrow 11-pica column width.

Psychologists like Tinker and Paterson have spent many years doing research studies similar to those mentioned above. These studies found, among many other things, that 9-point type set on a column width of from 16 to 24 picas is considerably easier to read than the standard 11-pica newspaper column.

Other research studies have found that more people will read a story set on a wider column measure. Also, readers in general believe that a wider column measure can be read more quickly than a narrower column measure and that the wider columns are also more attractive.

At the present time there are only four general circulation newspapers that have broken from tradition and changed to a wider column measure. These newspapers include: The Wall Street Journal, The National Observer, The Christian Science Monitor, and The Courier-Journal of Louisville, Kentucky. Generally speaking, these newspapers

changed their typography to make it easier, more convenient, and more pleasant for the reader to obtain maximum information.

As stated in Chapter I, it was the objective of this research to determine the production output difference, if such a difference exists, between the amount of type set in a given amount of time on the standard 11-pica newspaper column as compared to a 15-pica column. Subsidiary objectives were to determine the difference in errors between the two measures, the difference in hyphenization between the two measures, and the difference in words set per 100 ems between the two measures, if such differences exist.

The method used to ascertain this data was to have 30 line casting machine operators set two equivalent reading forms on an 11-pica measure and on a 15-pica measure for a five minute time period. An attempt was made to use one line casting machine, one style and size of type, and one spaceband thickness, but due to each shop's availability this was not possible. The experimental conditions were, however, kept as close as possible to actual newspaper publishing conditions. It should also be realized that the actual printed appearance of the type faces used in this experiment made no difference. The operators were being compared by the amount of material they could set on each measure in the alloted time, and, therefore, the readability or legibility of the type face made no difference. The only governing factor in the selection of a type face was the type's alphabet length.

During the testing period, the operator's setting time, the alphabet length, the spaceband thickness, the elapsed time of the test, and the machine and distributor stops were variables that were controlled as much as possible.

The operator's setting time was controlled by having each operator set for a ten-minute period. The alphabet length was controlled by using type faces with alphabet lengths equivalent to those used by modern newspapers. Spaceband thickness was controlled by using the same size bands used by modern newspapers. The elapsed time of the test was controlled by a stop watch. Machine and distributor stops were controlled by stopping the watch while the operator cleared the machine.

In this experiment two variables were manipulated. They were length of line and copy. The line width was alternated between 11 and 15 picas. The copy consisted of two forms of a diagnostic reading test that had been previously proven equivalent as to their reading difficulty.

During the actual testing period, each of the 30 operators was given the same instructions and followed the same procedure. The only change made, however, was to alternate the copy and the line width from operator to operator to eliminate a possible order bias.

The line casting machines used in this experiment, although not the newest models, were the same kind as used by most newspaper publishers today.

Before statistical analysis, each of the 60 proofs were checked for gross and net ems set on each column width, errors made on each column width, the number of hyphenated words on each column width, and the number of words set per 100 ems on each column width.

From the findings observed in Chapter III, it was found that the gross em increase amounted to 35.8 per cent more ems being set on the 15-pica measure than on the 11-pica measure. The net em increase, after deduction for errors, amounted to 17.4 per cent more ems being set on the 15-pica measure. Both the gross and net ems increases were found to be significant beyond the .01 level.

After tabulating the number of errors made per 100 ems on each measure, it was found that there were more errors made on the 15-pica measure than were made on the 11-pica measure. This difference, however, was found not to be significant.

Hyphenated words per 100 ems were calculated next and it was found that there were significantly more hyphenated words on the 11-pica measure than there were on the 15-pica measure. The level of significance reached here was beyond the .01 level.

The number of words set per 100 ems on each measure was the final area checked. It was found that there was a trend toward more words being set in 100 ems of type on the 15-pica measure, but the difference was not significant. The occurrence of a difference in means shown in Table 10 for the B copy set on each measure is believed to have been caused by a sampling bias due to the small number of operators sampled.

CONCLUSIONS

The majority of newspapers today set their news matter on a narrow column width which is somewhere in the area of 11 picas. Even though there has been some experimentation done on typography of newspapers, very few publishers have adopted the 15-pica column width as a standard.

The findings of this study seem to affirm the proposition that more type can be set on a line width of 15 picas in a given time period than can be set on an 11-pica measure in the same amount of time. These findings show that there were 35.8 per cent more gross ems set on the 15-pica measure in the five minute time period than were set on the 11-pica measure in the same time period. The net em increase amounted to 17.4 per cent more ems being set on the 15-pica measure than were set on the 11-pica measure. Both of these findings were significant beyond the .01 level. Therefore, it appears that by changing from the traditional 11-pica column to a wider and more readable column of 15 picas, efficiency and output in terms of ems may be significantly increased.

In terms of the number of hyphenated words required on each measure, there were significantly fewer hyphenated words required on the 15-pica measure than were required on the 11-pica measure. This level of significance was beyond the .01 level.

In terms of the difference in number of errors made on each measure, it was found that although there were more errors made on the 15-pica measure, no level of significance was reached.

In the area of words set per 100 ems on each measure, it was found that the trend was toward more words being set on the 15-pica measure than on the 11-pica measure. This difference was also found, as in the case of errors per 100 ems, not to be significant. The difference between the means in Table 10 for Copy B set on each column width is believed to have been caused by a sampling bias due to the small number of operators sampled.

In conclusion, the author realizes that the findings of this study appear to substantiate the hypothesis that by changing from the traditional 11-pica newspaper column to a wider column width of approximately 15 picas, efficiency and output will be significantly increased. He realizes, however, that these findings apply only to this particular study and may not apply with equal validity to all segments of the newspaper publishing industry.

RECOMMENDATIONS FOR FURTHER STUDY

In this experiment, the author studied the theoretical production output difference in terms of ems set by 30 operators by changing from a 11-pica column width to a 15-pica column width. Further studies should be conducted to determine what the optimum line widths are in various point sizes from the viewpoint of typesetting speed.

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APPENDIX A

603 Words
2684 Characters
4.45 Characters Per Word

COPY A

If human beings wore wings and feathers, very few of them would be clever enough to be crows. The common crow, whether in the wild state or kept as a pet, is a genius in feathers and an endlessly astonishing bird.

A crow owned by a lady in Stuart, Ohio, was so dainty that he insisted on washing worms before he would eat them. A Staten Island crow not only could pick pockets but when he found a pocket empty, would swear at his victim and fly away in a huff.

Not all crows can talk. Their individual ability varies greatly in this respect, and probably no crow can talk better if its tongue is split. Certain ones captured when young have been known to learn a hundred words and half as many complete phrases. There are even records of wild crows picking up and using such human expressions as "Giddyap!" and "Whoa!" and "Hey!" which they hear farmers shout in the fields.

When a crow does speak human language, he often gives the impression that he knows the exact meaning of what he is saying. A moonshiner, who had kept a pet crow as a lookout against government agents, was taken to jail. The human prisoner gave no trouble, but the bird proved something of a problem. He yelled, "I want water!"

when the supply in the cell began to dwindle. Whenever an attractive female visitor passed through the jail corridor, he thrust his neck between the cell bars, stared at the lady, and muttered, "Oh-boy-oh-boy-oh-BOY!"

The common crow, with his three closely related varieties, the Florida crow, southern crow and western crow, is found practically all over our country east of the Rocky Mountains, as well as in sections of the Northwest and along our western coast down to Southern California.

In building their nests, as in everything else, crows prove that they are individualists. Most often the nest, a bulky structure of coarse sticks, twigs, grasses and tree bark, lined with soft rootlets of fur or moss, is in an evergreen, and is about thirty feet from the ground. They often decorate their nests by inserting in them a shiney pebble or glittering pieces of glass.

As crows are always more or less clannish, there are usually a number of nests within a small area, and the occupants exercise their sly mischievousness by stealing each other's nesting materials. When one of the nesters flies off to feed for a while, one of his dark neighbors rushes to the unprotected nest, removes from it the choicest bits of moss and rootlets, and hides them in his own nest. Then, when the thief is absent from his nest for a while, the recently burglarized bird flies over and regains all the stolen goods, plus half a dozen other choice bits. This pilfering is probably a

friendly joke, for actually crows are devoted to one another and are bound by a sense of unity that leads them to show each other extraordinary courtesy and understanding.

The young stay in the nest about three weeks, consuming their weight in food every day, and by the time they are ready to leave they look almost like their parents except that their coats have less luster. For several days they practice flight maneuvers and wing drills before the critical elders of the flock. The oldsters show them the lay of the land and teach them the rules of the community of fifty or sixty crows nesting in the neighborhood.

Despite the individualism of its members, a flock is as disciplined as an

APPENDIX B

593 Words
2666 Characters
4.49 Characters Per Word

COPY B

The sly coyote that chatters and howls from lonely western hillsides tonight is probably boasting of another victory. He has been hounded more than any other American animal; every device and trick known to man--financed by local, state, and federal government--has been used in a long and unceasing battle to get rid of him. Between fifty and one hundred thousand are killed every year in this country, but the little wolf is holding his own and has spread from his original haunts in the prairies and mountains of the West to many a new neighborhood. Today at least two million roam the western United States looking for a mess of poultry or juicy lamb.

The coyote could retreat to the vast ranches and rough wastelands and live in peace, but that does not suit him. He is a wise fellow and delights in living among his enemies, matching wits with them and feasting on the food they produce.

A top-notch government trapper who found every one of his three dozen traps sprung and robbed of bait recently remarked: "The coyote is the smartest animal alive." A farmer who saw all the ripe watermelons in his patch opened and partly eaten had stronger words;

but he did wonder why the thief had not tried at least one green melon. There is a very good answer. Experts of the Wildlife Service have never found a single instance of a coyote's having bitten a green watermelon.

The coyote is a yellowish-gray animal resembling a small police dog. He seldom weighs more than thirty pounds. His speed has been clocked at forty miles an hour by an automobile. Scientists describe him as a lower or inferior member of the wolf family. That makes life no less dear to him. He thrives in regions in which the supposedly braver, wiser and more ferocious wolf is extinct.

Tricks help the coyote survive--tricks as clever as one pulled by Tippy, a pet reared by a family in Texas. Tippy's liking for fresh poultry stuck with him in captivity, and he began catching chickens. The family chained Tippy to a corner of the house and fed him scraps. Tippy promptly scattered the scraps within the length of his chain and retired around the corner. The chickens ventured forth to pick up the scraps, and Tippy picked up fresh poultry.

A fat coyote is seldom, if ever, seen. Regardless of the abundance of food, he stays in top condition for the running and fighting he knows he must do. As a fighter, he is quick as lightning and has a devilish trick of dragging his teeth through the flesh of any enemy he bites; a dog rarely asks for a second helping. But he fights only in emergencies, preferring to use cunning, either instinctive or developed.

A rancher walking or riding about his place without a gun may see coyotes at close range. He takes his gun the next time--and does not see a single one. Trappers for the Wildlife Service say the coyote's keen sense of smell detects the gun. Some people say the coyote has a special sense which other animals do not have.

The notion that the coyote possesses an almost supernatural sense is not new. Before Columbus discovered America, the inhabitants of Mexico recognized his cunning and often decorated their sculpture with the likeness of the smart little beast's head. And in Mexico today he lives in folklore and literature. He is still very much alive, too, and still respected by man. Natives tell

APPENDIX C

WARM UP COPY

When you read a book, a magazine, or a newspaper, you are using printing. Look about you during the day and observe the number of times you must depend on printing to obtain the information which you need. If you make a telephone call, a purchase at a store, prepare your lessons, answer an advertisement, select a breakfast food, find the date on a calendar, or do any of a hundred other things, printing guides your actions. As a user of printing, therefore, you should have an interest in the way printing is done.

The purpose of printing is to record ideas and thoughts on paper in a legible and attractive style, suited to the use that is to be made of the printed piece. In the simplest kinds of printing, type is set in lines of equal length and locked into a form. The form is then placed in a press, the type is inked, and an impression is made on paper. The final result of this process may be a calling card, a letterhead, a program, a folder, or a booklet. These are but a few of the common uses of printing. You will find it interesting to prepare a list of printed forms which are to be found in your school and home. A business office provides numerous additional examples.

Printing was invented about fifty years before the discovery of America. It has developed from a little-known art into one of the world's leading industries. Basic operations described above were

used by the printers of the fifteenth and sixteenth centuries in making books. This method is still used in many kinds of job printing, but more complex processes are used today in printing books, magazines, and newspapers.

APPENDIX D

LIST OF OPERATORS

1. Warren Anderson
2. Chuck Bechtold
3. Wayne Crownhart
4. Harry Dawson
5. Gary DuBois
6. Don Gangle
7. Phyllis Gates
8. Donald Graham
9. Hazel Hauff
10. Dennis Heiser
11. Fred Helmich
12. Fred Hemphill
13. Ray Horn
14. Ted Huettmann
15. Richard Huff
16. Larry Ingalls
17. Gary Lawton
18. Jim Lueneburg
19. Clyde Miller
20. Steve Miller
21. David Moritz
22. Don Nelson
23. Jack Nuckols
24. Frank Ouseley
25. Jan Peterson
26. Jim Potter
27. Charles Ridgeway
28. Ron Seeley
29. Virgil Turner
30. Joel Weiss